

DRAFT ONLY* City of Rehoboth Beach

Report for City of Rehoboth Beach Wastewater Treatment Plant Ocean Outfall Project

Environmental Impact Statement

February 2012



This Environmental Impact Statement for the City of Rehoboth Beach Wastewater Treatment Plant Ocean Outfall ("Report"):

- 1. has been prepared by GHD Inc. ("GHD") for the City of Rehoboth Beach, Delaware;
- 2. may only be used and relied on by the City of Rehoboth Beach, Delaware;
- 3. must not be copied to, used by, or relied on by any person other than the City of Rehoboth Beach, Delaware without the prior written consent of GHD;
- 4. may only be used for the purpose outlined.



i



Contents

١.	Sun	Summary					
	1.1	Back	ground and Current Treatment	1-1			
	1.2	Proje	ct Need	1-1			
	1.3	Proje	ct Purpose and Scope of Environmental Impact Statement	1-1			
	1.4	Alterr	native Analysis	1-2			
		1.4.1	Alternatives Considered	1-2			
		1.4.2	Comparison of Alternatives	1-3			
	1.5	Propo	osed Action	1-6			
		1.5.1	Recommended Plan	1-6			
		1.5.2	Wastewater Treatment Plant	1-7			
		1.5.3	Force Main	1-7			
		1.5.4	Ocean Outfall	1-9			
	1.6	Efflue	ent Characteristics and Concerns	1-10			
		1.6.1	Nutrients	1-10			
		1.6.2	Pathogenic Organisms	1-11			
		1.6.3	Metals, Volatiles, Semi-Volatiles, Phenolics, and Polychlorinated Biphenyls (PCBs)	1-11			
		1.6.4	Pharmaceuticals and Personal Care Products (PPCPs)	1-11			
	1.7	Ocea	n Modeling	1-12			
	1.8	Affected Environment and Environmental Consequences (Physical Environment)					
		1.8.1	Compared alternatives	1-14			
		1.8.2	Air Quality/Odor	1-14			
		1.8.3	Soils/Groundwater	1-14			
		1.8.4	Surface Water Quality/Quantity	1-14			
		1.8.5	Floodplains	1-15			
		1.8.6	Prime Agricultural Land	1-15			
		1.8.7	Cumulative Effects to the Physical Environment	1-15			
	1.9	Affec	ted Environment and Environmental Consequences (Biological Environment)	1-16			
		1.9.1	Terrestrial Biota/Habitat	1-16			
		1.9.2	Wetlands Biota/Habitat	1-16			
		1.9.3	Aquatic Biota/Habitat	1-16			
			1.9.3.1 Benthic Biota	1-16			



			1.9.3.2	Phytopiankton	1-17
			1.9.3.3	Submerged Aquatic Vegetation (SAV)	1-17
			1.9.3.4	Fish	1-17
			1.9.3.5	Marine Mammals	1-17
		1.9.4	Endange	red Species	1-18
			1.9.4.1	Sea Turtles in Delaware	1-18
		1.9.5	Cumulati	ve Effects to the Biological Environment	1-18
	1.10	Affec	ted Enviro	onment and Environmental Consequences (Human Environment)	1-18
		1.10.1	Growth a	nd Development	1-18
		1.10.2	2 Environm	nental Justice	1-18
		1.10.3	Commun	ity Facilities	1-19
		1.10.4	Economi	cs	1-19
		1.10.5	Project F	inancing	1-19
		1.10.6	Public He	ealth	1-20
		1.10.7	Noise		1-20
		1.10.8	Historic/A	Archeologic	1-21
		1.10.9	Aesthetic	cs/Recreation	1-21
	1.11	Conc	lusions ar	nd Preferred Alternative	1-21
2.	Intro	ductio	on		2-1
	2.1	Back	ground		2-1
	2.2	Proje	ct Need		2-1
	2.3	Proje	ct Purpos	e and Scope of Environmental Impact Statement	2-2
	2.4	Curre	nt Treatm	nent	2-3
		2.4.1	Effluent F	Requirements	2-9
		2.4.2	Performa	nnce	2-9
3.	Alte	rnative	e Analys	sis	3-1
	3.1	Alterr	natives Co	onsidered	3-1
		3.1.1	Alternativ	ve 1: No Action	3-2
			3.1.1.1	Description of Alternative	3-2
			3.1.1.2	Environmental Impact	3-2
			3.1.1.3	Cost	3-2
		3.1.2	Alternativ	ve 2: Nutrient Trading	3-2
			3.1.2.1	Description of Alternative	3-2



		3.1.2.2	Environm	ental Impact	3-4	
		3.1.2.3	Cost		3-5	
	3.1.3	Alternative 3: Land Application				
		3.1.3.1	Description	on of Alternative	3-6	
		3.1.3.2	Environm	ental Impact	3-8	
		3.1.3.3	Cost	- 111 V [*]	3-10	
			3.1.3.3.1	Alternative 3A: Dedicated Spray Irrigation Facility	3-10	
		D	3.1.3.3.2	Alternative 3B: Sending Raw Wastewater to WNRWF with Excess Flow Sent to the IBRWF	3-14	
			3.1.3.3.3	Alternative 3C: Sending Raw Wastewater to WNRWF with Exc	ess	
				Flow Sent to a PWWP	3-15	
			3.1.3.3.4	Alternative 3D: Sending Treated Effluent to WNRWF with Excelled Flow Sent to the IBRWF	ess 3-16	
			3.1.3.3.5	Alternative 3E: Cost of Sending Treated Effluent to WNRWF w	ith	
				Excess Flow Sent to a PWWP	3-17	
	3.1.4	Alternativ	Alternative 4: Rapid Infiltration Beds			
		3.1.4.1	Description	on of Alternative	3-18	
		3.1.4.2	Environm	ental Impact	3-19	
		3.1.4.3	Cost		3-21	
	3.1.5	Alternativ	e 5: Ground	d Water Injection	3-22	
		3.1.5.1	Alternative	e 5A: shallow wells	3-24	
			3.1.5.1.1	Description of Alternative	3-24	
			3.1.5.1.2	Environmental Impact	3-24	
			3.1.5.1.3	Cost	3-25	
		3.1.5.2	Alternative	e 5B: Deep Wells	3-25	
			3.1.5.2.1	Description of Alternative	3-25	
			3.1.5.2.2	Environmental Impact	3-27	
			3.1.5.2.3	Cost	3-27	
	3.1.6	Alternativ	e 6: Ocean	Outfall	3-28	
		3.1.6.1	Description	on of Alternative	3-28	
		3.1.6.2	Environm	ental Impact	3-31	
		3.1.6.3	Cost		3-33	
3.2	Comp	arison of	Alternativ	es	3-34	
Prop	osed	Action			4-1	
4.1	Recommended Plan 4-1					

4.



	4.2	Existi	ting Ocean Outfalls	4-1				
		4.2.1	Introduction	4-1				
		4.2.2	Delaware	4-2				
		4.2.3	Maryland	4-2				
		4.2.4		4-2				
		4.2.5	Florida	4-2				
		4.2.6	Florida California tewater Treatment Plant	4-3				
	4.3	Wast	tewater Treatment Plant	4-3				
	4.4	Force	e Main	4-4				
		4.4.1	Alignment	4-4				
		4.4.2	Construction Methods	4-6				
	4.5	Ocea	an Outfall	4-7				
		4.5.1	Location	4-7				
		4.5.2	Outfall Pipe	4-9				
		4.5.3	Diffuser	4-10				
		4.5.4	Construction Methods	4-12				
		4.5.5	Dredging Techniques	4-20				
			4.5.5.1 Backhoe/Bucket/Clamshell Dredger	4-20				
			4.5.5.2 Cutter Suction Dredger (CSD)	4-21				
5.	Efflu	ent C	Characteristics and Concerns	5-1				
	5.1	Efflue	ent Overview					
	5.2	Nutrie	ents					
	5.3	Patho	hogenic Organisms 5					
		5.3.1	Indicator Organisms	5-3				
		5.3.2	Water Quality Criteria	5-3				
		5.3.3	Removal in a Wastewater Treatment Plant	5-4				
		5.3.4	Concentration in Rehoboth Beach Wastewater	5-4				
	5.4	Metal	als, Volatiles, Semi-Volatiles, Phenolics, and Polychlorinated Biphenyls	(PCBs) 5-8				
		5.4.1	Water Quality Standards	5-8				
		5.4.2	Priority Pollutant Scan	5-8				
		5.4.3	Polychlorinated Biphenyls (PCB) Scan	5-9				
			5.4.3.1 Metals	5-10				
			5.4.3.2 Volatile Organic Compounds	5-11				
			5.4.3.3 Semi-Volatile Organic Compounds	5-12				



			5.4.3.4	Phenolics	5-12			
			5.4.3.5	PCB	5-12			
	5.5	Pharr	maceutica	als and Personal Care Products (PPCPs)	5-14			
		5.5.1	Sources	of Pharmaceuticals in the Environment	5-14			
		5.5.2	Concenti	ration of Pharmaceuticals in Typical Effluent	5-15			
		5.5.3	Pharmac	ceutical Impacts to Humans	5-19			
		5.5.4	Impact of	f PPCP exposure to Non-human species	5-22			
			5.5.4.1	PPCPs impacts on marine phytoplankton	5-22			
			5.5.4.2	Endocrine disruptor impacts on freshwater fish	5-23			
			5.5.4.3	Endocrine disruptor impacts on estuarine/marine fish	5-23			
			5.5.4.4	Excess antibiotics impacts on surface and groundwater	5-24			
6.	Oce	an Mo	odeling		6-1			
	6.1	Introd	duction		6-1			
	6.2	Field	Data					
		6.2.1	Field Dat	ta Collection	6-1			
		6.2.2	Field Dat	ta Analysis	6-5			
	6.3	Mode	ling Scop	6-5				
	6.4	Mode	ling Studies					
	6.5	Far-F	Far-Field Modeling					
		6.5.1	Description of Model					
		6.5.2	Model O	Model Operation				
		6.5.3	Forcing of	of the Model	6-8			
		6.5.4	Model Ca	alibration	6-8			
			6.5.4.1	Model Calibration to Predicted Tides	6-8			
			6.5.4.2	Calibration to Tide, Winds, Waves and Freshwater Inflows	6-9			
		6.5.5	Model Va	alidation	6-11			
		6.5.6	Verificati	on to Previous Work	6-12			
		6.5.7	Model Co	onclusions	6-13			
		6.5.8	Far-Field	Modeling Results	6-14			
			6.5.8.1	Modeling Assumptions	6-14			
			6.5.8.2	Qualifications	6-15			
			6.5.8.3	Presentation of Results	6-15			
			6.5.8.4	Timeframes	6-16			
			6.5.8.5	Southern Outfall – Instantaneous Plume Footprints	6-16			



			6.5.8.6	Southern Outfall – Dilution Map	6-16			
			6.5.8.7	Northern Outfall	6-18			
		6.5.9	Conclusion	ons - Far-Field Modeling	6-19			
	6.6	Near-	Field Mod	deling	6-20			
		6.6.1	Near-Fiel	ld Model Set-up	6-20			
		6.6.2	Aims	$\sim 111 \text{ V}^{*}$	6-21			
		6.6.3	Target Di	ilution e Characteristics	6-21			
		6.6.4	Discharg	e Characteristics	6-22			
		6.6.5	Input Dat	ta	6-22			
		6.6.6	Stratificat	Stratification				
		6.6.7	Model So	cenario Definition	6-24			
		6.6.8	Modeling	Results	6-25			
		6.6.9	Conclusion	ons	6-28			
		6.6.10	Qualificat	tions	6-29			
7.	Affected Environment and Environmental Consequences (Physical							
•		Environment)						
	7.1	Comp	oared Alte	ernatives	7-1			
		7.1.1	No action	n	7-1			
		7.1.2	Land App	olication	7-2			
		7.1.3	Ocean or	utfall	7-3			
	7.2	Air Quality/Odor						
		7.2.1	Air Qualit	ty/Odor Environment	7-4			
		7.2.2	Short Ter	rm / Temporary Impacts	7-5			
			7.2.2.1	No action	7-5			
			7.2.2.2	Land Application	7-5			
			7.2.2.3	Ocean outfall	7-6			
		7.2.3	Long Ter	m / Chronic Impacts	7-6			
			7.2.3.1	No action	7-6			
			7.2.3.2	Land Application	7-6			
			7.2.3.3	Ocean outfall	7-6			
	7.3	Soils/	Groundw	ater	7-6			
		7.3.1	Soils/Gro	oundwater Environment	7-6			
		7.3.2	Short Ter	rm / Temporary Impacts	7-8			
			7.3.2.1	No action	7-8			



		7.3.2.2	Land Application	7-8	
		7.3.2.3	Ocean outfall	7-8	
	7.3.3	Long Term / Chronic Impacts			
		7.3.3.1	No action	7-8	
		7.3.3.2	Land Application	7-8	
		7.3.3.3	Ocean Outfall	7-11	
7.4	Surfa	ce Water	Ocean Outfall Quality/Quantity Water Quality in Reheath Ray	7-11	
	7.4.1	Existing \	Water Quality in Rehoboth Bay	7-11	
	7.4.2	Existing	Water Quality in the Ocean	7-12	
	7.4.3	Sources	of Poor Water Quality	7-14	
		7.4.3.1	Stormwater Impacts	7-14	
	7.4.4	Short Te	rm / Temporary Impacts	7-15	
		7.4.4.1	No action	7-15	
		7.4.4.2	Land Application	7-15	
		7.4.4.3	Ocean outfall	7-15	
	7.4.5	Long Ter	rm / Chronic Impacts	7-16	
		7.4.5.1	No action	7-16	
		7.4.5.2	Land Application	7-17	
		7.4.5.3	Ocean Outfall	7-17	
7.5	Flood	lplains		7-17	
	7.5.1	Floodpla	in Description	7-17	
	7.5.2	Short Te	rm / Temporary Impacts	7-18	
		7.5.2.1	No Action	7-18	
		7.5.2.2	Land Application	7-18	
		7.5.2.3	Ocean Outfall	7-18	
	7.5.3	Long Ter	rm / Chronic Impacts	7-19	
		7.5.3.1	No Action	7-19	
		7.5.3.2	Land Application	7-19	
		7.5.3.3	Ocean Outfall	7-20	
7.6	Prime	e Agricultu	ural Land	7-20	
	7.6.1	Prime Ag	gricultural Land Definition	7-20	
	7.6.2	Short Te	rm / Temporary Impacts	7-23	
		7.6.2.1	No Action	7-23	
		7.6.2.2	Land Application	7-23	
		7.6.2.3	Ocean Outfall	7-23	



		7.6.3	Long Ter	rm / Chronic Impacts	7-23				
			7.6.3.1	No Action	7-23				
			7.6.3.2	Land Application	7-23				
			7.6.3.3	Ocean Outfall	7-23				
8.	Affe	cted E	nvironr	ment and Environmental Consequences (Biological					
	Envi	ironm	ent)		8-1				
	8.1	Terre	rrestrial Biota/Habitat						
		8.1.1	Terrestri	al Biota/Habitat Environment	8-1				
		8.1.2	Short Te	rm / Temporary Impacts	8-1				
			8.1.2.1	No action	8-1				
			8.1.2.2	Land Application	8-1				
			8.1.2.3	Ocean outfall	8-2				
		8.1.3	Long Ter	rm / Chronic Impacts	8-2				
			8.1.3.1	8.1.3.1 No action					
			8.1.3.2	Land Application	8-2				
			8.1.3.3	Ocean Outfall	8-4				
	8.2	Wetla	ands Biota/Habitat						
		8.2.1	Wetlands Biota/Habitat Environment						
		8.2.2	Short Term / Temporary Impacts						
			8.2.2.1	No Action	8-5				
			8.2.2.2	Land Application	8-5				
			8.2.2.3	Ocean Outfall	8-6				
		8.2.3	Long Ter	rm / Chronic Impacts	8-7				
			8.2.3.1	No Action	8-7				
			8.2.3.2	Land Application	8-7				
			8.2.3.3	Ocean Outfall	8-8				
	8.3	Aqua	tic Biota/l	Habitat	8-8				
		8.3.1	Benthic E	Biota	8-8				
			8.3.1.1	Benthic Environment	8-8				
				8.3.1.1.1 Benthic Environment in Rehoboth Bay	8-8				
				8.3.1.1.2 Benthic Environment in the Ocean	8-10				
			8.3.1.2	Short Term / Temporary Impacts	8-12				
				8.3.1.2.1 No Action	8-12				
				8.3.1.2.2 Land Application	8-12				



		8.3.1.2.3 Ocean Outfall	8-13
	8.3.1.3	Long Term / Chronic Impacts	8-13
		8.3.1.3.1 No Action	8-13
		8.3.1.3.2 Land Application	8-13
		8.3.1.3.3 Ocean Outfall	8-13
8.3.2	Phytoplar	nkton	8-14
	8.3.2.1	Phytoplankton environment	8-14
	8.3.2.2	Short Term / Temporary Impacts	8-14
		8.3.2.2.1 No Action	8-14
		8.3.2.2.2 Land Application	8-14
		8.3.2.2.3 Ocean Outfall	8-14
	8.3.2.3	Long Term / Chronic Impacts	8-15
		8.3.2.3.1 No Action	8-15
		8.3.2.3.2 Land Application	8-15
		8.3.2.3.3 Ocean Outfall	8-15
8.3.3	Submerge	ed Aquatic Vegetation	8-15
	8.3.3.1	Submerged Aquatic Vegetation Environment	8-15
	8.3.3.2	Short Term / Temporary Impacts	8-16
		8.3.3.2.1 No Action	8-16
		8.3.3.2.2 Land Application	8-16
		8.3.3.2.3 Ocean Outfall	8-16
	8.3.3.3	Long Term / Chronic Impacts	8-16
		8.3.3.3.1 No Action	8-16
		8.3.3.3.2 Land Application	8-16
		8.3.3.3.3 Ocean Outfall	8-16
8.3.4	Fish		8-17
	8.3.4.1	Local Fisheries Studies	8-17
	8.3.4.2	Essential Fish Habitat Species	8-19
	8.3.4.3	New England Essential Fish Habitat Species	8-29
		8.3.4.3.1 Atlantic Cod	8-29
		8.3.4.3.2 Red Hake	8-30
		8.3.4.3.3 Winter Flounder	8-32
		8.3.4.3.4 Windowpane Flounder	8-34
		8.3.4.3.5 American plaice	8-36
		8.3.4.3.6 Atlantic Sea Herring	8-37



		8.3.4.3.7	Monkfish (Goosefish)	8-38
	8.3.4.4	Middle Atla	antic Essential Fish Habitat Species	8-39
		8.3.4.4.1	Bluefish	8-39
		8.3.4.4.2	Atlantic Butterfish	8-40
		8.3.4.4.3	Summer Flounder	8-40
		8.3.4.4.4	Scup	8-41
		8.3.4.4.5	Black Sea Bass	8-42
		8.3.4.4.6	Surf Clam	8-43
		8.3.4.4.7	Spiny Dogfish	8-43
	8.3.4.5	South Atla	antic Essential Fish Habitat Species	8-44
		8.3.4.5.1	King Mackerel	8-44
		8.3.4.5.2	Spanish Mackerel	8-45
		8.3.4.5.3	Cobia	8-45
	8.3.4.6	Highly Mig	gratory Essential Fish Habitat Species	8-45
		8.3.4.6.1	Sand Tiger Shark	8-45
		8.3.4.6.2	Atlantic Angel Shark	8-46
		8.3.4.6.3	Atlantic Sharpnose Shark	8-47
		8.3.4.6.4	Dusky Shark	8-48
		8.3.4.6.5	Sandbar Shark	8-49
		8.3.4.6.6	Scalloped Hammerhead Shark	8-51
	8.3.4.7	Short Terr	n / Temporary Impacts	8-52
		8.3.4.7.1	No Action	8-52
		8.3.4.7.2	Land Application	8-52
		8.3.4.7.3	Ocean Outfall	8-52
	8.3.4.8	Long Tern	n / Chronic Impacts	8-53
		8.3.4.8.1	No Action	8-53
		8.3.4.8.2	Land Application	8-53
		8.3.4.8.3	Ocean Outfall	8-53
8.3.5	Marine Ma	ammals		8-53
	8.3.5.1	Marine Ma	ammal Environment	8-53
		8.3.5.1.1	Harbor Seal	8-54
		8.3.5.1.2	Gray Seal	8-55
		8.3.5.1.3	Harp Seal	8-56
		8.3.5.1.4	Hooded Seal	8-57
		8.3.5.1.5	Bottlenose Dolphin	8-57



			8.3.5.1.6	Harbor Porpoise	8-58
			8.3.5.1.7	Humpback Whale	8-59
			8.3.5.1.8	Fin Whale	8-60
		8.3.5.2	Short Terr	n / Temporary Impacts	8-61
			8.3.5.2.1	No Action	8-61
			8.3.5.2.2	Land Application	8-61
			8.3.5.2.3	Ocean Outfall	8-61
		8.3.5.3	Long Tern	n / Chronic Impacts	8-62
			8.3.5.3.1	No Action	8-62
			8.3.5.3.2	Land Application	8-62
			8.3.5.3.3	Ocean Outfall	8-63
8.4	Endar	ngered Sp	ecies		8-63
	8.4.1	Endanger	ed Species	in Delaware	8-63
	8.4.2	Sea Turtle	2 S		8-65
		8.4.2.1	Sea Turtle	es in Delaware	8-65
			8.4.2.1.1	Green Sea Turtle	8-66
			8.4.2.1.2	Hawksbill Sea Turtle	8-66
			8.4.2.1.3	Kemp's Ridley Sea Turtle	8-67
			8.4.2.1.4	Loggerhead Sea Turtle	8-67
			8.4.2.1.5	Leatherback Sea Turtle	8-68
		8.4.2.2	Short Terr	n / Temporary Impacts	8-69
			8.4.2.2.1	No Action	8-69
			8.4.2.2.2	Land Application	8-69
			8.4.2.2.3	Ocean Outfall	8-69
		8.4.2.3	Long Tern	n / Chronic Impacts	8-71
			8.4.2.3.1	No Action	8-71
			8.4.2.3.2	Land Application	8-71
			8.4.2.3.3	Ocean Outfall	8-71
Affe	cted F	nvironm	ent and	Environmental Consequences (Human	
	ronme		.o and		9-1
9.1	Grow	th and De	velopment	t	9-1
		Current P	•		9-1
			-	rary Impacts	9-3
		9.1.2.1	No Action		9-3

9.



		9.1.2.2	Land Application	9-3			
		9.1.2.3	Ocean Outfall	9-4			
	9.1.3	Long Te	rm / Chronic Impacts	9-4			
		9.1.3.1	No Action	9-4			
		9.1.3.2	Land Application	9-4			
		9.1.3.3	Ocean outfall	9-4			
9.2	Envir	onmental	Justice	9-4			
	9.2.1	Demogra	aphic background	9-5			
	9.2.2	Adverse	environmental impacts	9-6			
9.3	Planr	ning		9-7			
	9.3.1	Current I	Land Use	9-7			
9.4	Comr	munity Fa	acilities	9-8			
9.5	Econ	omics		9-8			
	9.5.1	Local Economy					
	9.5.2	Examples of Beach Communities					
		9.5.2.1	Virginia Beach, Virginia	9-10			
		9.5.2.2	Ocean City, Maryland	9-12			
		9.5.2.3	Bethany Beach, Delaware	9-13			
		9.5.2.4	Southern California Beaches	9-13			
	9.5.3	Short Te	erm / Temporary Impacts	9-14			
		9.5.3.1	No Action	9-14			
		9.5.3.2	Land Application	9-14			
		9.5.3.3	Ocean Outfall	9-14			
	9.5.4	Long Te	rm / Chronic Impacts	9-14			
		9.5.4.1	No Action	9-14			
		9.5.4.2	Land Application	9-14			
		9.5.4.3	Ocean Outfall	9-15			
9.6	Proje	ct Financ	sing	9-15			
	9.6.1	Financin	g Capital Construction	9-15			
	9.6.2	Annual L	Jser Charges	9-15			
		9.6.2.1	No Action	9-15			
		9.6.2.2	Land Application	9-15			
		9.6.2.3	Ocean Outfall	9-16			
		9.6.2.4	Comparison of Annual User Charges	9-16			
9.7	Publi	c Health		9-16			



9.7.1	Short Ter	m / Temporary Impacts	9-16
	9.7.1.1	No Action	9-16
	9.7.1.2	Land Application	9-17
	9.7.1.3	Ocean Outfall	9-17
9.7.2	Long Ter	m / Chronic Impacts	9-17
	9.7.2.1	No Action	9-17
		9.7.2.1.1 Impact of Nutrients	9-17
		9.7.2.1.2 Impact of Bacteria and Viruses	9-17
		9.7.2.1.3 Impact of Metals, Volatiles, and Semi-Volatiles	9-17
		9.7.2.1.4 Impact of Pharmaceuticals	9-17
	9.7.2.2	Land Application	9-18
		9.7.2.2.1 Impact of Nutrients	9-18
		9.7.2.2.2 Impact of Pathogenic Organisms in Aerosols	9-18
		9.7.2.2.3 Impact of Pathogenic Organisms in Groundwater	9-19
		9.7.2.2.4 Impact of Metals, Volatiles, and Semi-Volatiles	9-19
		9.7.2.2.5 Impact of Pharmaceuticals	9-20
	9.7.2.3	Ocean Outfall	9-21
		9.7.2.3.1 Impact of Nutrients	9-21
		9.7.2.3.2 Impact of Pathogenic Organisms	9-21
		9.7.2.3.2.1 Normal Operation	9-23
		9.7.2.3.2.2 Failure of Disinfection Process	9-24
		9.7.2.3.2.3 Failure of Tertiary Process	9-24
		9.7.2.3.3 Impact of Metals, Volatiles, and Semi-Volatiles	9-26
		9.7.2.3.4 Impact of Pharmaceuticals	9-27
Noise			9-27
9.8.1	Short Ter	m / Temporary Impacts	9-27
	9.8.1.1	No action	9-27
	9.8.1.2	Land Application	9-27
	9.8.1.3	Ocean outfall	9-28
9.8.2	Long Ter	m / Chronic Impacts	9-28
	9.8.2.1	No action	9-28
	9.8.2.2	Land Application	9-28
	9.8.2.3	Ocean outfall	9-28
Histor	ric/Archec	ologic	9-29
991	National I	Historical Preservation Act	9-29

9.8

9.9



9.9.2.1 No action	
0.0.2.1 100 000011	9-30
9.9.2.2 Land Application	9-30
9.9.2.3 Ocean outfall	9-30
9.9.3 Long Term / Chronic Impacts	9-33
9.9.3 Long Term / Chronic Impacts 9.10 Aesthetics/Recreation 9.10.1 Trip Activities in Sussex County 9.10.2 Short Term / Temporary Impacts	9-33
9.10.1 Trip Activities in Sussex County	9-33
9.10.2 Short Term / Temporary Impacts	9-34
9.10.2.1 No action	9-34
9.10.2.2 Land Application	9-35
9.10.2.3 Ocean outfall	9-35
9.10.3 Long Term / Chronic Impacts	9-35
9.10.3.1 No action	9-35
9.10.3.2 Land Application	9-35
9.10.3.3 Ocean outfall	9-35
10. Cumulative Impacts	10-1
10.1 Actions Affecting Resources of Concern	10-1
10.1.1 Past Activities and Projects	10-1
10.1.1.1 Beach Replenishment	10-1
10.1.1.2 Treated Effluent Discharge	10-6
10.1.1.3 Rehoboth Avenue Streetscape Project	10-7
10.1.1.4 Indian River Inlet Bridge	10-8
10.1.2 Present Activities	10-8
10.1.3 Future Projects	10-8
10.1.4 Climate Change	10-9
10.2 Potential Cumulative Impacts	10-9
11. List of Preparers	11-1
12. References	12-1
13. Glossary and Abbreviations	13-1



Table Index		
Table 1-1	Summary of Alternatives	1-3
Table 1-2	Proposed Ocean Outfall Locations	1-9
Table 1-3	Estimated Annual User Charges (Stearns & Wheler 2009)	1-20
Table 1-4	Summary of Environmental Consequences	1-23
Table 2-1	RBWWTP Measured Average Flows	2-3
Table 2-2	Rehoboth Beach NPDES Permit Limits (USEPA 2005a)	2-9
Table 2-3	Rehoboth Beach WWTP Current Effluent Performance Data	2-10
Table 3-1	Nutrient Trading Requirements	3-5
Table 3-2	Cost of implementing additional BMPs on agricultural land (DNREC 2008a)	C 3-5
Table 3-3	Cost of nutrient trading option	3-6
Table 3-4	Estimate of Probable Construction Cost for the RBWWTP Spray Irrigation System Alternative	3-13
Table 3-5	Alternative 3B Capital Cost Summary	3-14
Table 3-6	Alternative 3C Capital Cost Summary	3-15
Table 3-7	Alternative 3D Capital Cost Summary	3-16
Table 3-8	Alternative 3E Capital Cost Summary	3-17
Table 3-9	Estimate of Probable Construction Cost for the RBWWTP Rapid Infiltration Bed Alternative	3-21
Table 3-10	Deep Injection Well Probable Construction Cost Estimate	3-27
Table 3-11	Anticipated NPDES Permit Limits for Ocean Discharge	3-29
Table 3-12	Approximate Outfall Locations Considered in Lawler, Matusky & St Engineers Model (Stearns & Wheler 2005)	celly 3-30
Table 3-13	Rehoboth Beach - Distance and Time to Achieve 100:1 Dilution (St & Wheler 2005)	tearns 3-31
Table 3-14	Summary of Estimated Capital Costs – Ocean Outfall (Year 2009 Dollars)	3-33
Table 3-16	Summary of Alternatives	3-34
Table 3-17	Comparison of Alternatives	3-37
Table 3-18	Summary of Estimated User Charges (Stearns & Wheler 2009)	3-38
Table 4-1	Anticipated National Pollutant Discharge Elimination System (NPD Permit Limits for Ocean Discharge based on Current Limits at Sout Coastal RWF (USEPA 2005)	,
Table 4-2	Proposed Ocean Outfall Locations	4-7
Table 4-3	Preliminary Diffuser Design for Rehoboth Beach Outfall	4-11



Table 5-1	Description of different levels of treatment at a WWTP	5-1
Table 5-2	Nutrient Concentration Goals (DNREC 2004)	5-2
Table 5-3	Nutrient concentrations by level of treatment provided	5-2
Table 5-4	Criteria for primary contact in marine waters (DNREC 2004)	5-4
Table 5-5	Pathenogenic and indicator organisms typically present by level of treatment provided (No. per 100 mL)	5-5
Table 5-6	Pathogenic organism and resulting disease (Majeti and Clark 1980)	5-7
Table 5-7	Normal survival periods of pathogenic organism (Vigneswaran and Sundaravadivel 2004)	5-8
Table 5-8	Analyte Groups and EPA Methods of Priority Pollutant Scan (see (Appendix F))	5-9
Table 5-9	Measured Levels of Metals (see (Appendix F))	5-10
Table 5-10	Water Quality Criteria for Metals (DNREC 2004)	5-11
Table 5-11	Pharmaceuticals residual concentration (Khan and Ongerth 2005).	5-15
Table 5-12	Efficiencies of PPCPs removal with Tertiary Treatments Processes/Disinfection (Snyder, Wert, et al. 2007)	5-18
Table 5-13	Disorder of the human reproductive system possibly involving endoc disruptor compounds in their pathogenesis: A sexually dimorphic life cycle perspective (Diamanti-Kandarakis, et al. 2009)	
Table 5-14	PPCP's concentrations in raw drinking water, drinking water, and the Equivalent Level (DWEL) therapeutic dose (Snyder, Wert, et al. 2007 (Snyder, Vanderford, et al. 2008)	
Table 6-1	ADCP and CTD data collected at each outfall location	6-2
Table 6-2	CTD Collection Schedule	6-3
Table 6-3	Location of Transect Surveys	6-4
Table 6-4	Data Collection Instruments	6-4
Table 6-5	Total Area within a Given Dilution Contour for the Southern Outfall	6-17
Table 6-6	Total Area within a Given Dilution Contour for the Northern Outfall	6-18
Table 6-7	Diffuser Configuration as Initially Modeled	6-21
Table 6-8	Rehoboth Beach WWTP Current Effluent Performance Data	6-22
Table 6-9	Dilution Summary	6-27
Table 7-1	Air Quality Index (AQI) Data for Delaware Counties (USEPA 2008)	7-5
Table 7-2	Predominate soil types within project vicinity (NRCS 2006)	7-7
Table 7-3	Factors that may influence virus movement in groundwater (Gerba a Goyal 1985)	nd 7-10
Table 7-4	Water Quality Data within Rehoboth Bay (DNREC 2010a)	7-11



Table 7-5	Water Quality Data Collected (DNREC 2007) (Sharp 1998)	7-13
Table 7-6	Prime Farmland Soil Types (University of Delaware 2002)	7-21
Table 7-7	Statewide Important Farmland Soil Types (University of Delaware 20	02)7-21
Table 8-1	Amphipod species in Rehoboth Bay (Watling and Maurer 1972)	8-8
Table 8-2	Decapod species in Rehoboth Bay (Leathern and Maurer 1980)	8-10
Table 8-3	Mean abundance of the ten most abundant infaunal taxa in Area 6 (Scott 2001)	8-12
Table 8-4	Most Prevalent Observed Phytoplankton (USACE 1996)	8-14
Table 8-5	Top Ten Most Prevalent Species Observed Each Season in Area 6 (Wirth 2001)	8-18
Table 8-6	Essential Fish Habitat Species in the Area (NOAA 2011)	8-20
Table 8-7	Essential Fish Habitat Species in the Delaware Inland Bays (NOAA 2011)	8-21
Table 8-8	Habitats of Essential Fish Habitat Species in the Area (NOAA 1998)	8-23
Table 8-9	Endangered Species of Delaware (DNREC 2000)	8-63
Table 8-10	Turtle Species of Greatest Conservation Need (DNREC 2011) (USAC 2009)	E 8-65
Table 9-1	2010 Census Data for Rehoboth Beach, DE (U.S. Census Bureau 20	10)9-1
Table 9-2	Racial composition (U.S. Census Bureau 2010)	9-5
Table 9-3	Poverty status (U.S. Census Bureau 2010)	9-5
Table 9-4	Residents below poverty level by races (U.S. Census Bureau 2010)	9-6
Table 9-5	Estimated Annual User Charges (Stearns & Wheler 2009)	9-16
Table 9-6	Assessment criteria for inorganic constituents in treated effluent applito land (DNREC 1999)	ed 9-19
Table 9-7	Ambient nitrogen and phosphorus concentrations in the vicinity of the proposed outfall	9-21
Table 9-8	Survival rates for bacteria and viruses in fresh water (Metcalf & Eddy 2004)	9-22
Table 9-9	Assumed level of pathogenic organisms in effluent during normal operations	9-23
Table 9-10	Assumed level of pathogenic organisms in effluent during a failure of disinfection process (Rose, et al. 2001)	9-24
Table 9-11	Assumed level of pathogenic organisms in effluent during a failure of tertiary process and disinfection	9-25
Table 9-12	Pathogen levels and dilution required under various operating scenarious	ios9-25
Table 9-13	Percent change between sample sites for the number of detected chemicals and total PCCP concentration (Glassmeyer, et al. 2005)	9-27



Table 10-1

Table 10-2

Figure Index Figure 1-1 Force Main Plan 1-8 Figure 1-2 **Proposed Ocean Outfall Locations** 1-9 Figure 1-3 Contour plots showing the 95th percentile of dilution after 11 month of outfall operation at Southern and Northern Outfall Locations 1-13 Figure 1-4 Preferred Force Main Alignment and Outfall Location 1-22 Figure 2-1 **RBWWTP Recorded Flows** 2-4 **RBWWTP Process Flow Diagram** 2-5 Figure 2-2 Figure 2-3 **RBWWTP Existing Site Plan** 2-7 Figure 3-1 Inland Bay Sub-basin (DNREC 2008a) 3-4 Figure 3-2 Local Wastewater Treatment Plants 3-8 3-11 Figure 3-3 Sussex County Land Availability (Stearns & Wheler 2005) 3-12 Figure 3-4 Proposed Spray Irrigation Field Location 3-13 Figure 3-5 Proposed Spray Irrigation Field Site Plan Figure 3-6 Proposed Rapid Infiltration Bed Location 3-18 Figure 3-7 Proposed Rapid Infiltration Bed Site Plan 3-19 3-20 Figure 3-8 **Groundwater Mounding** Figure 3-9 Potential Well Injection Sites 3-23 Figure 3-10 Proposed Deep Well Injection Site Plan 3-26 Figure 3-11 Outfall Locations Considered in Lawler, Matusky & Skelly Engineers Model 3-30 Figure 4-1 Preliminary Effluent Pumping Station Location 4-4 4-5 Figure 4-2 Force Main Plan HDD Portion of the Proposed Effluent Force Main 4-7 Figure 4-3 Figure 4-4 Proposed Ocean Outfall Locations 4-8 4-9 Figure 4-5 Location of Hen and Chicken Shoals Figure 4-6 Ocean Outfall Profile (Not to scale) 4-10 4-10 Figure 4-7 Typical Ocean Outfall Cross Section Figure 4-8 Example Diffuser Schematic Diagram (not to scale) 4-12 4-13 Figure 4-9 Marine Borings

Beach Replenishment Projects (Western Carolina University 2005)

Summary of Environmental Consequences of Ocean Outfall Alternative 10-10

10-3



Figure 4-10	HDD Portion of the Proposed Outfall Pipe Alternatives	4-14
Figure 4-11	Mears Group's Horizontal Directional Drilling (HDD) process (Mears Group, Inc 2011)	4-15
Figure 4-12	Typical pipe mobilization for pull through bore hole	4-16
Figure 4-13	Directional Drilling Staging Area (Underground Solutions, Inc 2011)	4-17
Figure 4-14	Typical HDD drill site	4-17
Figure 4-15	HDD drill rig	4-18
Figure 4-16	HDD Exit Pit and Trench	4-18
Figure 4-17	Typical Concrete Weight Cross Section	4-19
Figure 4-18	Diffuser profile	4-20
Figure 4-19	Diffuser Concrete Weight Connection	4-20
Figure 4-20	Clamshell dredge	4-21
Figure 4-21	Cutter Suction dredge	4-22
Figure 6-1	Location of Buoy Deployment and Transect Surveys	6-4
Figure 6-2	Simulation Domain	6-7
Figure 6-3	Depth-averaged mean flow velocity for the duration of the Fall 2010 fiestudies (left) and depth-averaged mean flow velocity for 1993 (right) sourced from the dissertation of Dr. M Whitney (Garvine 2003).	eld 6-13
Figure 6-4	Southern Outfall: Contour plot showing the 95th percentile of dilution after 11 month of outfall operation	6-17
Figure 6-5:	Northern Outfall: Contour plot showing the 95th percentile of dilution after 11 month of outfall operation	6-19
Figure 6-6	Schematic Diagram of Modeled Diffuser	6-20
Figure 6-7	Measured Current Magnitude at 8.2 ft (2.5 m) above the seafloor (% Occurrence)	6-23
Figure 6-8	Near-Field Dilutions for Simulation Cases 000 to 006	6-26
Figure 6-9	Near-Field Dilutions for Simulation cases 007 and 008	6-26
Figure 7-1	No Action Alternative	7-2
Figure 7-2	Land Application Alternative	7-3
Figure 7-3	Ocean Outfall Alternative	7-4
Figure 7-4	Soils Types Within Project Vicinity (NRCS 2006)	7-7
Figure 7-5	Soils Within Dedicated Land Application Facility (NRCS 2006)	7-9
Figure 7-6	Water Quality Data Collection Locations (DNREC 2007) (Sharp 1998)	7-13
Figure 7-7	Stormwater Outfalls in Rehoboth Beach (Salin 1992)	7-15
Figure 7-8	Flood Hazard Areas Along the Land Application Forcemain Alignment (FEMA 2005)	7-18



Figure 7-9	Flood Hazard Areas Along the Ocean Outfall Forcemain Alignment (FEMA 2005)	7-19
Figure 7-10	Flood Hazard Areas Near the Dedicated Land Application Facility (FEMA 2005)	7-20
Figure 7-11	Prime and Statewide Important Farmland (NRCS 2006)	7-22
Figure 8-1	Key Wildlife Habitats within the Land Application Facility (Allen, Barku and Bennett 2006)	ıs 8-3
Figure 8-2	Local Wetlands (U.S. Fish and Wildlife Service 2011)	8-5
Figure 8-3	Wetlands Impacted by Land Application Alternative (U.S. Fish and Wildlife Service 2011)	8-6
Figure 8-4	Wetlands Impacted by Ocean Outfall Alternative (U.S. Fish and Wildli Service 2011)	fe 8-7
Figure 8-5	USACE Report Study Areas (Scott 2001)	8-11
Figure 8-6	USACE Fishery Study Areas (Wirth 2001)	8-17
Figure 8-7	Essential Fish Habitat Area of Interest (NOAA 2011)	8-20
Figure 8-8	Sub-regions of the Northeast continental Shelf Ecosystem (NEFSC 2007)	8-29
Figure 8-9	Adult Atlantic Cod Essential Fish Habitat (NOAA 1998)	8-30
Figure 8-10	Red Hake Essential Fish Habitat for A) Eggs B) Larvae, C) Juveniles, and D) Adults (NOAA 1998)	8-32
Figure 8-11	Winter Flounder Essential Fish Habitat for A) Eggs B) Larvae, C) Juveniles, and D) Adults (NOAA 1998)	8-34
Figure 8-12	Windowpane Flounder Essential Fish Habitat for A) Eggs B) Larvae, C Juveniles, and D) Adults (NOAA 1998)	C) 8-36
Figure 8-13	American Plaice Essential Fish Habitat for A) Juveniles, and B) Adults (NOAA 1998)	8-37
Figure 8-14	Atlantic sea herring Essential Fish Habitat for A) Juveniles, and B) Adults (NOAA 1998)	8-38
Figure 8-15	Monkfish Essential Fish Habitat for Eggs and Larvae (NOAA 1998)	8-39
Figure 8-16	Essential Fish Habitat for coastal migratory pelagic species including king mackerel, Spanish mackerel, and cobia	8-44
Figure 8-17	Sand Tiger Shark Essential Fish Habitat for A) Neonates, B) Juveniles and C) Adults (NOAA 2011a)	s, 8-46
Figure 8-18	Atlantic Angel Shark Essential Fish Habitat for Neonates, Juveniles at Adults (NOAA 2011a)	nd 8-47
Figure 8-19	Atlantic Sharpnose Shark Essential Fish Habitat for A) Neonates, B) Juveniles, and C) Adults (NOAA 2011a)	8-48



Figure 8-20	Dusky Shark Essential Fish Habitat for A) Neonates, B) Juveniles and Adults (NOAA 2011a)	8-49
Figure 8-21	Sandbar Shark Essential Fish Habitat for A) Neonates, B) Juveniles, and C) Adults; and D) Habitat Areas of Particular Concern (NOAA	
	2011a)	8-51
Figure 8-22	Scalloped Hammerhead Shark Essential Fish Habitat for Juveniles (NOAA 2011a)	8-52
Figure 8-23	Highest diversity of marine mammals in the U.S. mid-Atlantic (Kenney 2000)	, 8-54
Figure 8-24	Approximate coastal range of harbor seals (Waring, et al. 2009)	8-55
Figure 8-25	Approximate coastal range of gray seals (Waring, et al. 2009)	8-56
Figure 8-26	Harp seal high density area (Waring, et al. 2009)	8-57
Figure 8-27	Distribution of bottlenose dolphin sightings from NEFSC and SEFSC aerial surveys during the summer in 1998, 1999, 2002, 2004, and 200 (Waring, et al. 2009))6 8-58
Figure 8-28	Distribution of harbor porpoises from NEFSC and SEFSC shipboard a aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006 a 2007 (Waring, et al. 2009)	
Figure 8-29	Distribution of humpback whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002 2004 2006, and 2007 (Waring, et al. 2009)	2, 8-60
Figure 8-30	Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 20 and 2007 (Waring, et al. 2009)	
Figure 8-31	Seasonal distribution and spatial boundaries for prospective stocks of the coastal morphotype of bottlenose dolphin along the Atlantic coast (Waring, et al. 2009)	
Figure 8-32	Aerial Sightings of Green Turtles (NOAA 2011)	8-66
Figure 8-33	Aerial Sightings of Kemp's Ridley Sea Turtles (NOAA 2011)	8-67
Figure 8-34	Aerial Sightings of Loggerhead Sea Turtles (NOAA 2011)	8-68
Figure 8-35	Aerial Sightings of Leatherback Sea Turtles (NOAA 2011)	8-69
Figure 8-36	Distribution of Juvenile Loggerhead Turtles from May to October (a) a from November to April (b) (Mansfield, et al. 2009)	nd 8-70
Figure 9-1	Historic Population Trend for the City of Rehoboth Beach (Rehoboth Beach-Dewey Beach Chamber of Commerce 2009)	9-3
Figure 9-2	Historic and Projected Population for the Delaware and Sussex Count (Rehoboth Beach-Dewey Beach Chamber of Commerce 2009)	ty 9-3
Figure 9-3	Median household income surrounding project area	9-6



Figure 9-4	Current Land Use	9-7
Figure 9-5	Total Jobs by Industry in Sussex County (Rehoboth Beach-Dewey Beach Chamber of Commerce 2009)	9-8
Figure 9-6	Monthly Visitor Volume for Sussex County during 2006 and 2007 (Delaware Economic Development Office (DEDO) 2007)	9-9
Figure 9-7	City of Virginia Beach Hotel rooms (Yochum and Agarwal 2010)	9-11
Figure 9-8	City of Virginia Beach Visitor spending and city revenue (Yochum and Agarwal 2010)	d 9-12
Figure 9-9	Enterococcus Dilution	9-26
Figure 9-10	Properties listed in the National Register of Historic Places (Advisory Council on Historic Preservation (ACHP) 2004).	9-29
Figure 9-11	Extents and Found Targets of Previous Submerged Cultural Resourc Surveys	e 9-31
Figure 9-12	Extents and Found Targets of 2011 Submerged Cultural Resource Survey	9-32
Figure 9-13	Trip Activities in Sussex County (Delaware Economic Development Office (DEDO) 2007)	9-34
Figure 10-1	Cumulative Impact Study Area	10-2
Figure 10-2	2005 and 2011 Beach Replenishment Projects (USACE 2004) (USAC 2010)	CE 10-6
Figure 10-3	Existing WWTP outfalls (Clean Ocean Action 2001) (USEPA 1992)	10-7
Figure 10-4	Rehoboth Avenue Streetscape Project	10-8



Appendices

- A Consent Order
- B Rehoboth Beach Wastewater Treatment Plant Cost Benefit Analysis
- C Documentation of Land Search Effort
- D Reverse Osmosis System Cost Estimate
- E Lawler, Matusky & Skelly Engineers 2003 Dilution Model
- F RBWWTP Priority Pollutant Scan
- G Rehoboth Beach Wastewater Treatment Plant Effluent Forcemain Study
- H Marine Boring Logs
- I Polychlorinated Biphenyls (PCB) Scan.
- J GHD Ocean Model
- K Previous Water Quality Data
- L Field Data Instrument Calibration Reports and Practices
- M Drilling Mud MSD Sheet
- N Potential Impacts of Treated Wastewater On Atlantic Bottlenose Dolphins
- O Submerged Cultural Resource Survey



This page intentionally left blank

